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***Answers to Exercises***

IN

**AN INTRODUCTION TO  
MATHEMATICAL  
ANALYSIS**

BY

**FRANK LOXLEY GRIFFIN**

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Answers  
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## ANSWERS TO EXERCISES

N.B. Very slight inaccuracies in graphical results are to be ignored.

### Pages 8-10

- |                                       |                                  |
|---------------------------------------|----------------------------------|
| 1. 37.2 gm., 15.3 gm., $-6.5^\circ$ . | 2. 13.6 in., 10,900 ft., 6.8 in. |
| 3. 81,800, 64.7 yr., 9600.            | 5. 12.7 kg., 3.17 lb.            |
| 6. \$24.                              | 7. 12.3 mi.                      |

### Pages 12-13

- |                                |                       |                  |
|--------------------------------|-----------------------|------------------|
| 1. \$3990, 23.8 yr.            | 2. 13.5 yr., 49.7 yr. | 3. \$680 per yr. |
| 4. $-2.4$ min., April 20, etc. | 5. 1.8 larger.        | 6. 23 d., 81 d.  |

### Pages 16-18

- |  |  |
|--|--|
| 1. $t = 1.39$ , 300 per hr., 820 per hr.           | 2. $46.3^\circ$ , 5.7 deg./min.          |
| 3. 825 mg., $T = 1800$ , ..., .26 mg./yr. (decr.). | 4. 5200 ft., 1040 ft./min., 610 ft./min. |
| 5. 21.5 mi./hr., ..., 2.4 mi./hr. per ton/hr.      | 6. .86 sq. cm./day.                      |

### Pages 20-21

- |   |                   |              |              |
|---|-------------------|--------------|--------------|
| 2. $11^\circ$ .   | 3. 75615.         | 4. 25.87 in. | 5. 11.72 yr. |
| 7. 101.43, 839.2.   | 8. 13.5296, 28.8. | 10. .7052.   |              |
| 11. 1.03, .00075 H.P./R.P.M., $v = 1950$ gives $p = 1.17$ . |                   |              |              |

### Pages 22-24

- |                                     |                                     |           |
|-------------------------------------|-------------------------------------|-----------|
| 4. 76.56, 9.3541; ...               | 5. ..., 49046.                      | 7. 10:30. |
| 8. \$6550, 132 ft.; \$12.80 per ft. | 9. ..., 33 ft./min. gained per min. |           |
| 10. 39600 ft.                       |                                     |           |

### Pages 27-29

- |  |                           |
|--|---------------------------|
| 1. 343000 ft., 36 ft./min. lost per min.               | 2. 193 ft./min., 10.1 ft. |
| 3. 78400 ft.   | 4. 502.5 ft.              |
| 5. 3500 million mi., 14.5 million mi./yr. lost per yr. |                           |
| 7. 171 ton-sec., 23 tons/sec.                          | 8. 16 in.-lb.             |
| 9. 38900 ft.-lb.                                       | 10. 12900 ft.-lb.         |
| 11. 14500 amp./sec., .34 coulombs.                     | 12. 2570 kw.-hrs.         |

M553509

## Pages 30-31

1. 2730 sq. yd.      2. 20700 sq. ft.      3. 223000 cu. ft.  
 4. 1,640,000 cu. ft.; decr. 2370 sq. ft./ft.      5. 320 cc.  
 6. 416,000 cu. ft.

## Pages 33-35

2. 6.25 in.      3. 3.33 in., 592.6 cu. in.      4. 7.75 yd., 15.49 yd.  
 5. 3:12 P.M., 48 mi.      6. 8.66 in.      7. 11.55 in., 16.33 in.  
 8. 8.32 in.  $\times$  12.49 in.      9.  $14 \times 14 \times 28$  cu. in.      10. 20 yd., 30 yd.,  
     \$240.  
 11. 6.21 ft.  $\times$  3.11 ft.      12. 4.54 yd.  $\times$  3.63 yd.      13. 3.92 in., 1056  
     cu. in.

## Pages 39-40

1.  $\frac{9 \pm \sqrt{57}}{4}$ ;  $\frac{10}{3}, -2$ ;  $\frac{5 \pm \sqrt{-11}}{12}$ ;  $-\frac{1}{5}, -\frac{1}{5}$ ;  $-2 \pm 3\sqrt{-1}$ ;  
 $\frac{-3 \pm 6\sqrt{3}}{11}$ ;  $\pm 2, \pm 1$ ;  $\pm \frac{1}{2}\sqrt{-5 \pm \sqrt{113}}$ ;  $\frac{1}{6}(-7 \pm \sqrt{49 - 12c})$ ;  
      $.1(-b \pm \sqrt{b^2 + 140})$ .  
 2. 3.24 in.; 9.26 in.      3. .658 in.      4.  $10 \pm \sqrt{20}$ .  
 5. -2.21, .54, 1.68; -2.19, 3.19; -2.67; -3.97, -.49, .52, 2.95.  
 7. 2.38.      8. 2.82, 12.5, 22.18.      11. 6, only.

## Pages 41-42

1. -1.68, 1.61, 4.07; -2.95, .78, 2.17; -1.85, -.70, .58, 3.97;  
     3.18 only; -4.03, 5.02 only; -2.04 only;  
      $x^2 = -3.56, .56$ ;  $x^2 = -3.97, .90, 3.07$ .  
 2. 10.17 ft.      3. 4.11 in.      4. No imaginaries.

## Pages 44-45

4. 96.32 ft./sec.      5. 196 ft.,  $\frac{1}{2}(7 \pm \sqrt{29})$ .      6. 47.84 ft./sec.  
 7. .244 ft. per ft.      9. 15800 cu. ft.      10. 25.3, ..., 35.8.

## Pages 49-50

4. Four break, one twice.      5. -25, 37.5.      7. 11.86, 9.65.  
 8.  $E = .08 W$ ; 2.8.      10.  $V = 4500/p$ .      11.  $R = .072 V^2$ .  
 12.  $A = 512,000,000/R^2$ .

## Page 53

1.  $W = 54 + .5 T$ .      3.  $V = 182 + \frac{1}{2} T$ .  
 5.  $L = 605 - .69 T$ .      6.  $M = 4.19 h - 132$ .

# ANSWERS TO EXERCISES

iii

## Pages 55-57

- |                                  |                                    |
|----------------------------------|------------------------------------|
| 3. decr. .84 sq. cm./day.        | 4. \$365, \$52 per yr.             |
| 6. 1835 yd., .062 mils/yd.       | 7. 29200 sq. ft.                   |
| 8. 19400°.                       | 9. 1380 deg./min. gained per min.  |
| 10. 4.70, -20 per sec., 2.54 in. | 12. -5.34; -2.91, -.68, .64, 3.95. |
| 15. 44¢.                         | 16. 16.2 cal., 3.33 ft. from A.    |
|                                  | 17. 8.91 in., 28 in.               |

## Pages 62-63

- |                   |                        |                    |
|-------------------|------------------------|--------------------|
| 3. 140 ft./sec.   | 4. 40 ft./sec.         | 5. 320 ft./sec.    |
| 6. 10 sq. in./in. | 7. $12\pi$ sq. in./in. | 8. -500/441 units. |
| 9. 180 units.     | 10. -500 units.        |                    |

## Page 65

- |                             |                       |
|-----------------------------|-----------------------|
| 2. 18.85 in., 28.27 sq. in. | 3. 1100 mi., 2100 mi. |
|-----------------------------|-----------------------|

## Pages 68-69

- |              |              |  |       |
|--------------|--------------|--|-------|
| 1. .75, etc. | 2. 16%, etc. | 4. .24.  | 5. 2. |
| 6. 4.        | 8. .3.       | 9. $-\frac{1}{6}$ ; av. slope = $-1/(9+3\Delta x)$ . |       |

## Pages 73-74

- |                                |   |
|--------------------------------|---|
| 5. 100, etc.                   | 7. ..., -18.75; ..., $32+27\Delta x+9\Delta x^2+\Delta x^3$ . |
| 8. 12, ...                     | 9. 2.   |
| 11. 2 ft./sec. gained per sec. | 10. -2.5 dynes/cm.  |

## Page 77

- |                                       |                               |
|---------------------------------------|-------------------------------|
| 1. $360-32t$ ft./sec., ..., 2025 ft.  | 2. $3x^2-6, \pm\sqrt{2}$ .    |
| 3. $-600/p^2$ cu. in. per lb./sq. in. | 6. $4\pi r^2$ cu. ft. per ft. |

## Page 81

- |   |                            |
|---|----------------------------|
| 1. $2x, 3x^2, 4x^3, \dots, 2x-9, -7/x^2, 70-10t$ , etc. | 3. -10.25, $x = 4.5$ .     |
| 2. ..., 245 ft.   | 6. -.6.                    |
| 5. $4-4t$ ft./sec. gained per sec.                      | 8. $-40/x^3$ dynes per cm. |
| 7. 180 units per in.                                    |                            |

## Page 84

- |                        |                     |                         |
|------------------------|---------------------|-------------------------|
| 3. 48 ft. per ft./sec. | 5. 1200 cu. in./in. | 6. 3.68 ft. per mi./hr. |
|------------------------|---------------------|-------------------------|

## Pages 86-87

- |  |                                |
|--|--------------------------------|
| 1. ..., $14x^3+\frac{1}{8}x^2$ .                   | 2. ..., $10ax^5+8x^3/b$ , etc. |
| 3. $360x-60x^2, 5x^4+8x^3+15x^2-2x-2, 36x^3-60x$ . |                                |
| 4. 2.4 ft./sec. per sec.                           | 5. .028.                       |



6. 15000 cu. ft. per ft.      7. 3000 units/min.; incr., decr.  
 8. 18; incr.      12.  $-.6819, -1.0899$ ; etc.  
 13.  $2x+5-3/x^2$ .      14.  $2x-22/x^3$ .  
 16. .4 lb., approx.

## Page 89

2. 78.54%.      3. 52.36%.

## Pages 90-92

1. 7; 7.0035.      2. .215.      3. .00093.      4. .6 cu. in., .24 sq. in.  
 5. .0015 in., .0025 in.      6. .85 sq. in., .126 ft., ....  
 7. .00199 ft., ....      8. 7.54 sq. in., ..., 3.77 sq. in.      9. .0125 cm., ...  
 10. .6%, .0125%.      11. 35.2 ft.      12. .0123 ton, ...  
 13. .0138.      14. 7.2¢ per hr., ....

## Pages 95-96

1.  $x = 3, y = -4$ ;  $x = -1, y = -1$ ; max.  $y = 17$ , min.  $y = -15$ ;  
 none; max.  $y = 10$ , min.  $y = -6$  (twice); min.  $y = -332$ .  
 2. .04.      3. 538.2+.      4.  $16000/27$  cu. in.  
 5.  $t = 80\%$ .      6.  $x = 1/2$ .

## Pages 97-98

1. 400 sq. in.      3. 7.5, 7.5.      4.  $-1/2$ .  
 5.  $78\frac{1}{8}$  sq. in.      6.  $20\sqrt{3}/3, 20\sqrt{6}/3$ .      7.  $14 \times 14 \times 28$  cu. in.  
 8. 48 mi.      9. 44¢, approx.      10.  $x = 4\sqrt{15}, L = 8\sqrt{15}$ .  
 12. radius = vertical side = 4.20 ft., approx.

## Page 100

4. .3,  $10\%$ , -, -, 6,  $1/4$ , -,  $1/6$ ,  $3/8$ .      5. 1.5, 145.5.  
 7.  $x = 5$ .      8.  $y = 40/x^2$ .      10.  $-2/x^2$ .

## Pages 102-103

1. (a)  $-4/x^5$ , -, -,  $180/x^{11}$ , etc.      2.  $-.411$ .  
 3.  $-.016$ .      4.  $-3$ .      5.  $-1.28$ .  
 6.  $-2.5$ .      7. \$240.      8.  $7.83^*$  ft.,  $6.52^*$  ft.  
 9.  $9.28^*$  ft.,  $4.64^*$  ft.      10.  $r = 5$  in.,  $h = 5$  in.      12.  $r = 3.97^*$  in.,  
 $h = 15.87^*$  in.  
 13.  $\sqrt{20}$ .      14. 40 in.      15.  $66+6\sqrt{40}$  sq. in.      16.  $65.98^*$  sq. in.  
 17.  $r = h = \sqrt[3]{231/\pi}$  in.      18. 270 sq. in.      19. 600 sq. in.

## Page 106

1. ...,  $550/x^{12}$ , ...,  $-6t$ .      3.  $12096x^3-5040/x^3$ .

\* Approximately.

# ANSWERS TO EXERCISES

v

4.  $80-32t$ , 48 ft./sec.,  $-32$  ft./sec.<sup>2</sup> 6. 12, 12. 7. .008, .004.  
10. 20 ft./sec., 8 ft./sec.<sup>2</sup> 12. 0, 1600 ft./min.

## Page 109

2.  $t = 12$ . 4. 18, 6. 5. 20; 8,800,000 units/min.  
7. ..., -15.

## Page 112

1.  $6x(u^2-2)$ , etc. 3.  $36x^2t^3$ , etc. 4. 24 cu. in./hr.  
5. (a)  $400x^3(x^4+25)^{99}$ ; (d)  $-4\pi(1-x)^3$ ; (e)  $-420t^2/(t^3-1)^3$ ; (g)  $3/4(8-t)^2$ .  
6. incr. 1.058\*. 7. 16.2.

## Pages 115-116

1. -, -,  $(-.008/x^3)dx/dt$ , ...,  $(1+168/L^3)dL/dt$ .  
2.  $32\pi$  cu. ft./min. 4. .5 in./min. 5. .7957\* in./hr.  
6. .00159\* ft./min. 8. .000707\* in./hr. 9. .00955\* in., 2.4 sq. in.  
10. -.3 units/min. 11. .0087\* cc./min. 12. .02188\* ft./deg.

## Pages 118-119

2. .225 ft./sec. 3. 64 ft./sec. 4. 7.5 ft./min.  
5.  $-40\sqrt{5}$  ft./sec.;  $t = 30$ , 1000 ft. 6. -92 ft./sec.  
7.  $\frac{5}{8}\sqrt{110}$ . 8. 21.69\* ft./sec. 9. 32.49\* ft./sec.  
10. incr., 14 mi./hr. 11. 1.44; 96 mi. 12. .533\* in./min.

## Page 121

2.  $4\sqrt[3]{x}/3$ , ...,  $-5/2\sqrt{x^7}$ . 3. ...,  $-40/3\sqrt[3]{x^5}$ .  
4. .0053 sec. 5. .037 yr. 6. 756.  
7. .122 mi. 8. .4 ft./sec. per ft. 9. (a)  $7x\sqrt[3]{(x^3+1)^4}$ .  
9. (f)  $8(x-5)/\sqrt[4]{(x^2-10x+7)^3}$ ; (i)  $400t^6/9\sqrt[3]{(25-t^2)^4}$ . 10. 3 hr.

## Page 123

1.  $dy = 2x dx$ , etc. 4.  $dx/dt$ , etc.

## Pages 124-125

3. ...,  $-20/x^5 - 28x/(10-x^2)^3$ . 4. \$12.48, 2.88, 7.21 ft., approx.  
5. 110 yd. each. 6.  $144\pi$  cu. in./hr. 7. 2.4 sq. in./min.  
8. 24 cu. in. 9. .0318 in. 10. 12; 4.  
12. 5; 300. 13. ...,  $30\sqrt{2}$  ft./sec. 14.  $45^{10/18}$  mi./hr.  
15.  $100^{1/18}$ . 16. -500 per in.; 625;  $-1/1728$  in. per ft.  
17. ...,  $t = 100$ ; -1600 ft./sec.

\* Approximately.

## Pages 130-131

1. (b) ...,  $8\sqrt{x^7} + 2x + C$ . (c) ...,  $\frac{1}{2}x^7 + kx + C$ .  
 3. ...;  $y = \frac{2}{3}\sqrt{x^3} + 25x - \frac{3}{2}x^4 + 25\%$ . 5. 671 lb.  
 8. 10,000. 9. 1100, 8400, etc. 11. 83.3 lb., approx.

## Pages 133-134

2.  $60 + 80t - 16t^2$ ;  $\frac{5}{2} + \sqrt{10}$ . 4. ..., 42000 ft.,  $50 \pm 20\sqrt{5}$ .  
 5.  $-80\sqrt{30}$  ft./sec. 6.  $t = 12.22$ ;  $-441$  ft./sec., approx.  
 8.  $t = 15$ ; 450 in. 9. 468.75 ft. 10.  $-98.71$  ft./sec.  
 11. 1600 ft. 12. 45 ft./sec., 675 ft. 16.  $2.67$ ;  $\frac{1}{2}x^3$ .

## Page 137

1. 150. 2. 114. 3. 19375. 4.  $40, 89\frac{1}{11}, 8\frac{3}{8}, 11.25, .105, 2$ .  
 5. 1248.75. 6. 32. 7.  $256\frac{1}{8}$  ft.-lb.

## Pages 140-141

1. 774 lb.-ft. 2. 7500, 380, -, 328. 3. 250 in.-lb.  
 4. 30000 in.-lb. 5. 2 dyne-cm. 6.  $3933\frac{1}{3}$  mi.-lb.  
 7.  $1.4(10^{-20})$  dyne-cm. 8.  $992\pi$ . 9. 486 cu. ft.  
 10. 972 cu. in. 11.  $.3\pi$  cu. ft. 12.  $533\frac{1}{3}$  cu. in.  
 14. 5236 cu. in. 15.  $5333\frac{1}{3}$  cu. in.

## Page 145

4.  $20000\pi$ . 5.  $309\pi$ . 6. ...; 3485.1 cu. in.  
 7. 11670 cu. ft. 8.  $11666\frac{2}{3}$  cu. ft. 9.  $66\frac{2}{3}$  cu. in.  
 10.  $\frac{2}{3}hr^3$ . 11. 144 cu. in. 12.  $5333\frac{1}{3}$  cu. in.  
 13.  $85\frac{1}{2}$  cu. in. 14.  $2666\frac{2}{3}$  cu. in.

## Pages 149-150

1. 843750 lb. 3. 1,406,250 lb. 4. 937500 lb. 5. 375 lb.  
 6. (c)-(e)  $-\frac{1}{8}(25-x^2)^{\frac{3}{2}} + C$ ,  $18\sqrt{x^2+9} + C$ ,  $-\frac{7}{32}(8-x^2)^{11} + C$ .  
 8.  $2666\frac{2}{3}$  lb. 9.  $5208\frac{1}{3}$  lb. 11. Final value, 36000 lb.

## Pages 152-153

1. .000 000 000 693+. 2. .000 000 01354+. 3. 5 lb. 4. 2250 lb.  
 5. 50000 lb. 6. .4. 7.  $1333\frac{1}{3}$  cu. in. 8. 6000 lb.  
 11. 72 cu. in. 13. 6000 in.-lb.  
 15. 1000 ft.; approaching, 128 ft./sec. 16.  $t = \sqrt{125}$ .  
 17.  $12.5(1 + \sqrt{5})$ ; 12.5. 19. 254.68. 20. 61.42 sq. in.

# ANSWERS TO EXERCISES

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## Page 159

- |                          |                         |                           |
|--------------------------|-------------------------|---------------------------|
| 4. 607 ft.               | 5. 614 ft.              | 6. 210 lb., 22°.          |
| 7. 700 lb., 38°.         | 8. 200 lb., 37°.        | 9. 550 lb., 53°.          |
| 10. 429 lb., 473 lb.     | 11. 115 lb., 231 lb.    | 12. 1000 lb., 866 lb.     |
| 13. 13100 lb., 10700 lb. | 14. 311 tons, 238 tons. | 15. 180000 lb. 156000 lb. |

## Pages 165-166

- |   |                        |                        |
|---|------------------------|------------------------|
| 4. $\frac{5}{13}, \frac{\sqrt{63}}{63}$ . | 5. .09, 5°.            | 6. 548 ft.             |
| 7. 9°.                                    | 8. 63.7 lb., 186 lb.   | 9. 22°.                |
| 10. 1410 ft.                              | 11. 1.38 mi.           | 12. 12.3 mi., 49.5 mi. |
| 13. 62° N. of E.                          | 14. 5.2%, etc.         | 16. 5°, etc.           |
| 18. 22°.                                  | 19. 14400 lb., etc.    | 20. 10.5 ft.           |
| 21. 4830 sq. cm.                          | 22. 23°, etc.          | 25. 391 lb., etc.      |
| 26. 60°.                                  | 28. 31°, etc.          | 29. 4.79 mi./hr., etc. |
| 30. 24.7 ft./sec.                         | 31. 58° N. of E., etc. | 33. 24000 ft.          |

## Page 168

- |                  |                   |                          |
|------------------|-------------------|--------------------------|
| 2. 944 ft., etc. | 3. 31°, etc.      | 6. .918, etc.            |
| 7. 8506 ft.      | 8. 2250 lb., etc. | 9. 123 in., 1170 sq. in. |
| 10. 1580 mi.     | 11. 3630 mi.      | 15. 17900 cu. in.        |

## Pages 170-171

- |                                |                      |                          |
|--------------------------------|----------------------|--------------------------|
| 1. 9.21 ft., etc.              | 2. 30.3 in.          | 3. 6.05 in.              |
| 4. 107 sq. in.                 | 6. 122 sq. in., etc. | 7. 559 cu. in.           |
| 8. 205 sq. in.                 | 9. 308 lb., 948 lb.  | 11. 337 lb.              |
| 12. N. 5.37 mi./hr., etc.      | 13. S. 15.8 mi./hr.  | 14. 13.8, 10.8, ft./sec. |
| 15. 3.03 m./s., etc.           | 16. 948 lb.          | 17. 95100 ft.-lb.        |
| 18. .866 sq. ft., .342 sq. ft. |                      |                          |

## Pages 173-174

- |            |                    |                         |                  |
|------------|--------------------|-------------------------|------------------|
| 1. 350 lb. | 3. 18500 lb., etc. | 4. 3000 lb., etc.       | 6. 653 lb., etc. |
| 7. 133 lb. | 8. 6500 lb.        | 9. 43600 lb., 35700 lb. | 10. 230 lb.      |

## Page 175

- |                         |                                      |
|-------------------------|--------------------------------------|
| 2. .08985, ..., 1.0735. | 3. 955.36 ft., 2°.87.                |
| 5. 111.07 sq. in.       | 6. 628.32 sq. in., 362.76 sq. in.    |
| 7. 1.0515 in.           | 9. 311.76 lb. [ $w = 6 - 2.6864x$ ]. |
| 10. 1.6782 ft./min.     | 11. .00187 in./min.                  |

## Page 177

2. (I) 79°22', 213.22, 695.68. (II) 623.01, 71°1'5, 55°41'5.  
 (III) 69°53'4, 72°0'1, 392.97; or, 110°6'6, 31°46'9, 217.62.

## Pages 179-180

- |                         |  |
|-------------------------|--|
| 2. 439.20, 315.68, etc. | 3. 482.77, $53^{\circ}1'.4$ , etc.     |
| 5. 5115.8 yd.           | 6. 3177.5 yd.                          |
| 7. 91,570,000 mi.       | 8. 70 lb., $38^{\circ}12'.8$ from 2nd. |
| 9. Incr. 58.06 ft./sec. |  |

## Page 183

- |  |             |                        |
|--|-------------|------------------------|
| 1. ..., .77875, .62733.  | 3. 13 tons. | 4. $75^{\circ}31'.4$ . |
| 5. 108 mi.   | 6. 1014 ft. | 7. 683.78 ft.          |
| 8. (i) $99^{\circ}28'.4$ ; $41^{\circ}4'.8$ , etc. (iii) 4.493; $97^{\circ}1'$ , etc. (v) 9784.5; $34^{\circ}57'.5$ ; etc. (vi) 76.880; $49^{\circ}21'.9$ , etc.; or 26.212; $130^{\circ}38'.1$ , etc. (vii) 11189; 5023.1, etc. |             |                        |
| 9. (i) 111240. (iii) 14.517. (v) 19,188,000. (vi) 1134.7; 386.89. (vii) 24,609,000.  |             |                        |

## Page 184

- |               |               |               |
|---------------|---------------|---------------|
| 1. 1821.1 ft. | 2. 1809.5 ft. | 3. 2867.5 ft. |
|---------------|---------------|---------------|

## Pages 186-188

- |  |   |                                    |
|--|---|------------------------------------|
| 4. $47^{\circ}11'.4$ .                     | 5. 12078 yd., $6^{\circ}27'.9$ N. of E. |                                    |
| 7. 743.37 sq. ft., or 346.63 sq. ft., etc. | 9. 126.42 ft.                           |                                    |
| 11. $82^{\circ}5'.8$ .                     | 12. 223,200,000 mi.                     | 13. 21.048 ch.                     |
| 16. 1683.9 cu. ft.                         | 17. 10 ft.                              | 19. 8.16 in.                       |
| 20. 4 in., 3.3282 in.                      | 21. 9234; 11877.                        | 23. 204.02 lb., $22^{\circ}0'.4$ . |
| 24. 2865.3 ft.                             | 25. 3104.9 ft.                          | 26. 182.49 ft.                     |
| 27. 224.45 ft.                             | 28. $73^{\circ}18'$ .                   | 29. $3.775 \times 10^{15}$ mi.     |
| 30. $101^{\circ}32'.2$ .                   | 31. .375 ft./sec.                       | 32. 233.4 cu. in.                  |
| 33. 32235 lb.                              | 34. ..., $50^{\circ}11'.7$ .            | 35. $17^{\circ}39'.4$ .            |
| 36. .0031215 ft./min.                      |   | 37. .2 lb./min.                    |

## Pages 191-192

- |                         |          |             |          |
|-------------------------|----------|-------------|----------|
| 3. $2.73 \times 10^9$ . | 4. 50.9. | 6. 4670 yr. | 9. 9.44. |
|-------------------------|----------|-------------|----------|

## Page 198 \*

- |  |
|--|
| 4. (a)-(e) 3432; 965,200; 7,260,000; 2.438; 979.9. |
| (f)-(j) 7.235; 1.796; 3.347; 26.22; 10,210,000.    |
| 7. 41.52; .00191. 9. 3.78.                         |

## Pages 200-201 \*

- |   |
|---|
| 2. (a)-(c) 1.288; .04756; .0004569. (d)-(f) .001947; .0007791; .002025.           |
| (g)-(i) 1.262; .2892; .001913. (j)-(l) $4.168 \times 10^{-6}$ ; .01545; .0002235. |
| 3. .02129; 13.81; 7.706; 7171. 4. $2.015 \times 10^{12}$ . 5. 10.91.              |

\* The answers given in groups are not always in order.

# ANSWERS TO EXERCISES

ix

## Page 202 \*

- |                   |               |             |
|-------------------|---------------|-------------|
| 3. --211, ---989. | 4. --093 sec. | 5. \$20530. |
| 6. \$3768.80.     | 7. --822 ft.  | 8. 10.552.  |

## Page 206

- |                                   |                             |
|-----------------------------------|-----------------------------|
| 3. (a)-(c) --.403, ---868, --902. |                             |
| (d)-(f) ---8872, --.068, --.212.  |                             |
| 4. --344.                         | 5. --988 $\times 10^{11}$ . |
|                                   | 6. 2361.5 cu. ft., etc.     |

## Pages 208-209

- |                  |                      |                            |
|------------------|----------------------|----------------------------|
| 1. -4.15; --390. | 3. -11.938.          | 4. 134,220 sq. cm.         |
| 5. 384.86 ft.    | 6. $19^{\circ}44'$ . | 7. ( $\neq$ ) .16057, etc. |

## Page 212 †

- |                      |               |                |
|----------------------|---------------|----------------|
| 1. \$10,421,000,000. | 2. \$3979.60. | 3. 5.7%.       |
| 7. 4.64%.            | 9. \$1104.20. | 11. \$3359.10. |

## Page 214

- |                         |                                 |             |
|-------------------------|---------------------------------|-------------|
| 1. 2.3219; 2.1827, etc. | 2. $9.45+$ , 28.08, 13.13, etc. | 3. \$30072. |
|-------------------------|---------------------------------|-------------|

## Page 217

- |   |                         |            |
|---|-------------------------|------------|
| 3. $42^{\circ}27'.7$ ; 54.707 in.; etc.                                       | 5. 982.92; 816.70; etc. | 6. 980.57. |
| 7. (i)-(iii) 415.42, 169.65; etc.; .67640, .70432, etc.; 11.007, 20.497, etc. |                         |            |
| (iv)-(v) 1134.2, 999.9; etc.; 46.289, 4.2878, etc.                            |                         |            |
| 8. 44.088 ft.   | 9. $20^{\circ}21'.9$ .  |            |

## Page 220

- |  |   |
|--|---|
| 1. $27^{\circ}31'.2$ , $91^{\circ}18'$ , $61^{\circ}10'.9$ . | 3. (i) $38^{\circ}41'.2$ , $86^{\circ}37'$ , etc. |
| 3. (iii) $113^{\circ}4'.2$ , $36^{\circ}56'.1$ , etc.        | (v) $64^{\circ}41'.8$ , $33^{\circ}47'.8$ , etc.  |
| 4. $80^{\circ}31'.3$ .                                       | 5. $88^{\circ}42'$ .                              |

## Page 222

- |   |   |                    |
|---|---|--------------------|
| 1. $38^{\circ}14'.9$ , ..., 70.233.                 | 2. ..., $48^{\circ}31'.7$ , 50.938.           | 3. 547.84; 929.72. |
| 4. (i) ..., $110^{\circ}45'.4$ , 1944.4; 1,169,000. | (iv) ..., $38^{\circ}14'.3$ , 7.8946; 10.172. |                    |
| (vi) ..., $40^{\circ}3'.5$ , 167.40; 5186.6.        |   |                    |

## Pages 226-227

- |  |               |
|--|---------------|
| 1. (c)-(g) 421.33; --.13764; 54.708; 1.0931; --.25546. |               |
| (h)-(l) --7.1470; .0012565; 9965.5; 2.4304; 626.69.    |               |
| 2. \$5306.70.  | 3. \$3494.20. |
| 4. 4.52%.  | 5. 22.5.      |

\* Each dash stands for a figure, perhaps zero, in the answer.

† These answers were obtained from five-place tables and are consequently somewhat inaccurate.

## MATHEMATICAL ANALYSIS

6. .19708.      7. 88.191 ft.      8. 369.17 ft.      9. 173.13 ft.  
 10. 389.79 ft.    11. 154.03.      12. 380.76 ft. or 452 ft.    13. 1650.7 ft.

*Review Set, pages 228-235*

## Chapter I

2.  $-4.56$  sq. ft./ft.; 160 cu. ft.  
 3.  $(19 \pm \sqrt{249}) \div 14$ ;  $-2.33$ ,  $.20 +$ ,  $2.13$ .

## Chapter III

7. \$792.35.      8.  $t = 4$ ; 80.5 cu. ft.      11.  $x = 2$ ,  $\Delta x = .005$ .  
 12. 14417 units/min.; .14716 units/min.

## Chapter IV

2. ..., 42000 ft.; ..., 1639.52 ft./sec.    3. 50.4.    4. 37500.  
 5. 218,750 lb.      7.  $9\pi$  cu. in.      8.  $1.08\pi$  lb.

## Chapter V

3.  $24^\circ 1'$ .    4. 13584 lb., 18376 lb.    6. 297.6 ft.    7. 10233 lb.

## Chapter VI

1. 73.42; 1.5416;  $(\pm?)$  .17394.    2. 26,017,000,000 mi.  
 3. 13.51.    4. 99.53 ft.    5. .35158 mi.

*Miscellaneous, pages 232-235*

1. 141.03 ft.    2. .01749 ft./min.    3. 50000 ft.;  $t = 6$ ; 10935 ft./min.  
 5.  $\int 2400 \pi x dx$ .    6.  $27000 \pi$  cu. ft.    7. 2000 ft.,  $-208$  ft./sec.  
 8. By trial,  $t = 13 -$ .    11. 1875.    12.  $2.87 +$ .  
 14.  $-8.2571$  lb./in., 1330.9 in.-lb.    16.  $8.75\%$ .\*    17.  $21.6 -$ .\*  
 18.  $45^\circ$ ; etc.    20. 4.1669 cu. in.; etc.    21. 2098.1 ft.    22. 98.33 lb.  
 23. 300 lb./sec. (Constant).    24. \$2636.20.    25. 85 in.-lb.  
 26. 189,590 lb.    27. 78.446.    28. 118,150 cu. in., approx.  
 29. 1.869 ft./sec.    30. .0129.

*Pages 240-241*

1. \$2473.10.    2.  $5.13\%$ .    3.  $t = 24.08$ .    4. \$41161.  
 5.  $5.824\%$ .    6. 91492; 203610; ....    7. 448.  
 8.  $t = 2.31$ .    9. 68.387 mg.    10. 82.088,  $t = 9.21$ .  
 11. 9.902.    12.  $3.922\%$ .

*Page 243*

1.  $10^{.00888888}$ , ....    2. ..., 12.5353, 7.3132-10, 3.0088-10.

\* Substituting  $x$  for an expression gives a cubic equation.

# ANSWERS TO EXERCISES

xi

3. 1.8379, ..., 4.7574-10.      4. -, 202, -, .457, .0454.  
 5. 1.597, ..., .002813, .1247.      6. 2.305, 7652, 6.419.  
 7. .09119; 10.9-.      8.  $e^{.69313}$ ,  $e^{.23327}$ .

## Page 247

3.  $t = 4.48$ -.      5. ...,  $Q = 50 e^{-30t}$ .      6. 21.972%.

## Pages 254-255

1.  $f = 36/x^2$ .      2. One C. I. L., one Power L.      3.  $D = 29.4 e^{-57t}$ .  
 5.  $R = 3000 e^{-.08t}$ .      6.  $V = .25 e^{-.06931T}$ .      7.  $N = 100 e^{-5t}$ .  
 8.  $p = 2000/V^{\frac{1}{3}}$ .      9.  $T = \sqrt{D^3}$ .

## Pages 259-260

2. .69330.      7. (a)-(c)  $\frac{20}{x}, \dots, \frac{-4}{x}, \frac{1}{x}, \dots, \frac{3}{x}, \frac{-5}{2x}, \frac{1}{2x}, \dots, \frac{-1}{3x}$ .  
 7. (d)  $\frac{3}{2x}, \frac{-28}{3x}$ .      8. 2.3026.      10. 486.6.  
 11. 5.056.      12. +260.6 ft.      13. 465.3 ft./min.  
 14. (b)  $\frac{.86858x}{x^2-25}, \frac{-2.17145x^4}{1-x^5}$ .      15. ...;  $\frac{4}{x}$ .  
 16.  $\frac{1-x^2}{x(x^2+1)}, \frac{2(1-x^4)}{x(x^4+1)}, \frac{2x^2-1}{x(x^2-1)}, \frac{2x}{(x^2-1)(x^2+1)}$ .  
 17.  $\frac{2x^3}{x^3+1}, \frac{1}{x \log x}$ .      18. ...;  $\frac{1}{y} \frac{dy}{dx}$ .

## Page 261

1.  $-\frac{x^2+1}{(x^2-1)^2}; \dots; 14x(7x^3-1)(x^3-1)^3; 5x^2(5x^4+3)/\sqrt{x^4+1}$ .

## Pages 263-264

1.  $1.2 e^{.06x}; \dots; -56x/e^{4x^2}; 6(e^{6x}-e^{-6x})$ .      2. (a)  $2.1972x3^x$ .  
 9.  $i = 30 e^{-.60t}$ .      13.  $995^\circ$ .\*      15. 23.6 in.      17.  $n = Ne^{kt}$ .

## Pages 266-267

1. (b)  $-\frac{2x(3x^3+4x^6+10)}{(x^3-5)^2};$  (c)  $4x \log x;$  (d)  $2xe^{4x}(2x+1);$   
 (f)  $\frac{2x(25-2x^4)}{\sqrt{25-x^4}};$  (g)  $\frac{1-6 \log x}{x^7};$  (h)  $\frac{-2x(x^4+1)}{(x^4-1)^2};$

\* By five-place tables.



- (i)  $\frac{4}{(e^x + e^{-x})^2}$ ; (j)  $\frac{400}{(x^2 + 400)^{\frac{3}{2}}}$ ; (l)  $\frac{t^2(3+t)}{(1+t)^3}$ .
2. (a)  $x = \sqrt[3]{e}$ ,  $y = \frac{1}{3e}$  (max.). (b)  $x = \frac{3}{4}$ ,  $u = \dots$  (max.).  
 (d) min. at  $-\sqrt{50}$ , max. at  $\sqrt{50}$ .
4. 30 cu. in./min. 5. inc.  $50\pi$  cu. in./min. 6. .2424 deg./min.  
 7. dec. 2.1875 per min. 8. dec. .1 per min. 9. inc. .00176 per min.
11.  $S = 1/2 e$ , when  $x = \sqrt{e}$ . 12.  $x = 2\sqrt{2}$ .

## Pages 268-270

2.  $10/x$ ,  $10(\log x)^3/x$ ,  $(1 - \log x)/x^2$ ,  $2xe^{x^2}$ ,  $3e^x(e^x + 1)^2$ .
3. (a)-(c)  $1.30287(\log_{10} x)^2/x$ ,  $(3x+4)/2x(x+1)$ ,  $(1-5\log x)/x^4$ .  
 (e), (f), (h).  $\frac{2x(2x^4+1)}{\sqrt{x^4+1}}$ ;  $2x^3e^{-10x}(2-5x)$ ;  $\frac{-4}{(e^t - e^{-t})^2}$ ;  
 (i), (j).  $2x(\log x)^2$ ;  $2x^3e^{2x}$ .
5.  $x = \pm\sqrt{2}/2$ . 6. inc. 4.375 per min. 7.  $x = 200(1 - e^{-2t})$ .  
 8. 8.664%. 9. 13.86. 10. 32.894.  
 12. Only .3%. 16.  $I = 600/x^2$ . 17.  $I = 100e^{-.2D}$ .  
 18.  $S = 6.2e^{-.18t}$ , approx. 19.  $f = 18400/d^{\frac{4}{3}}$ , approx.  
 20.  $R = 29.2e^{-.622t}$ ; 1 less.

## Pages 273-274

2.  $FC = 4.919$  mi.,  $26^\circ 34'$  N. of E. 3. 13892 m.,  $30^\circ 15' 4''$  N. of E.  
 5. ..., 49.729 mi. 6. 18.4 ft. 7. 422 sq. ft. 8. 814 sq. ft.  
 10. 1494 ft. 11.  $t = 5$ ;  $x = 1200$ .

## Pages 276-277

2. 913 ft./sec.,  $28^\circ 49'$  up; etc. 3.  $x = 30000$ ;  $v = 1000$ ;  $I = -36^\circ 52'$ .  
 5.  $3+3i$ ; 76. 8.  $2(17^{\frac{3}{2}} - 1)$ ; 24; 224

## Pages 278-279

1.  $x = 1399.4t$ ,  $y = 540t - 16t^2$ . 2.  $t = 33.75$ ,  $x = 47230$ , ...  
 3.  $t = 1\frac{1}{2}$  sec; (135.32, 39.06). 4. ...; 580.9 ft.

## Pages 281-282

1. 10, ..., 201.91. 5.  $-54^\circ 28'$ , etc. 11. 750.  
 12.  $\sqrt{2873}$ ,  $\sqrt{3793}$ . 14.  $\sqrt{109}$ ,  $\sqrt{157}$ , etc. 15. Yes, no, yes.  
 18.  $31^\circ 16'$ . 19.  $74^\circ 30'$  (if prolonged). 20. 16.35 mi.

# ANSWERS TO EXERCISES

xiii

## Pages 285-286

2. No. (Test?)      8. (4, 4); also . . .      12. The inscribed circle  
13.  $x^2 + y^2 = 100$ .      14.  $x^2 + y^2 = 16$ .      15.  $x^2 + y^2 = 64$ .

## Page 288

7. No; no. (Test?)      10. Unlimited line, or sides of a square, according to interpretation of "distance."  
8.  $2x - y = 9$ .

## Pages 290-291

2. (b)  $(x-5)^2 + (y-4)^2 = 25$ .      (c)  $(x+2)^2 + (y-3)^2 = 37$ .  
4.  $(-8, 15)$ ,  $r = 17$ ; etc.      5. . . . ;  $(-\frac{5}{4}, 0)$ ,  $r = \frac{5}{4}$ .  
8.  $(x+4)^2 + y^2 = 64$ .      9. (15, 7).  
11. . . . , 16; etc.      13. 200; 150; . . . ; 32.  
14. . . . ;  $22\pi$ ,  $10\pi$ .

## Page 293

6. Straight line.      7. Circle, or straight line.  
8. Circle. (What center?)      9.  $y^2 = 12x$ , simplified.

## Pages 296-297

2.  $F(0, \frac{1}{4})$ , Dir.,  $y = -\frac{1}{4}$ ; etc.      3. If in doubt, read § 198.  
5.  $x^2 = 25y$ .      6. . . . ; 2.      7. . . . ; (i.e.,  $y = .000142x^2$ ); etc.  
8.  $x^2 = 1600y$ ; etc.      9. 6 ft., etc.      13.  $x^2 = 100y$ ;  $\frac{3}{4}$  in.

## Pages 298-299

1. (0, -10), etc.      4.  $x^2 = -4y$ .      5.  $x^2 = -400y$ ; 3 in.  
6. 7.4 in.; -.0463.      8. 24.8 ft., 63.2 ft.      9.  $\frac{x^2}{400} + \frac{y^2}{144} = 1$ .

## Pages 302-303

1.  $(\pm 15, 0)$ ; . . . ,  $(0, \pm 2\sqrt{5})$ .      4. (c)  $\frac{x^2}{25} + \frac{y^2}{16} = 1$ ; (d)  $\frac{x^2}{169} + \frac{y^2}{144} = 1$ .  
7.  $b = 92,986,000$ ; etc.      8. (a) 38.4; (b) 40, when  $x = 5/\sqrt{2}$ .  
10. 5.508 ft.; etc.      11.  $\frac{x^2}{100} + \frac{y^2}{25} = 1$ .      12.  $\frac{x^2}{400} + \frac{y^2}{144} = 1$ .

## Pages 305-306

1.  $500\pi$  sq. in.      4.  $2500\pi$  cu. in.      6. 8 ft.; etc.      9.  $\frac{4}{5} = \cos C$ ;  
 $S = \frac{C}{360}(\pi r^2)$ .      12.  $\frac{x^2}{2500} + \frac{y^2}{900} = 1$ . [Use similar triangles.]  
13.  $\frac{x^2}{400} - \frac{y^2}{225} = 1$ .



# ANSWERS TO EXERCISES

xv

9. Same as in Ex. 8. 12. (3, 6), (0, 6).  
 13.  $9x^2 - 16y^2 - 144x + 128y + 176 = 0$ .  
 14.  $x^2 - 120000x + 160000y = 0$ ; (60000, -17500).  
 15.  $y = -.00092098x^2$ . 16. 3.8%.  
 17. About  $48^\circ$  S. of W. 18.  $y = \frac{1}{20}x^2 + C$ .  
 19.  $Y^2 = 8X$ . 21. Hyperbola (Why?); 85.836 in.-lb.  
 22.  $P = .05V^2$ ; 1.

## Page 328

3.  $\pm 3, \pm 1$ ;  $3, \frac{3}{2}(-1 \pm \sqrt{-3})$ ; etc. 4. 13.49. 5. 10.39.  
 6. .5193  $l$ . 7.  $E, P, H$ , pair of lines.

## Pages 329-330

2.  $Y$ , not  $X$ . (Why?) 3. (a), (b) Yes. 4.  $k = \frac{3}{4}$ ;  $x = \frac{4}{3}, \frac{4}{3}$ .  
 5.  $(-4; -2, -2)$ ; etc. 6.  $-\frac{3}{4}$ , etc. 7.  $k = 50$ , or ... (Why two?).

## Pages 333-334\*

1. (a)-(e) 2, 3,  $(-7 \pm \sqrt{37})/2$ ; 1, -4, ...; -2, -4, ...;  
 -1, -2, 5, ...; 1, -1, ...; (f)-(j) 5, -4, -1, ...;  $\frac{1}{2}, -3, \dots$ ;  
 $\frac{3}{8}, -\frac{1}{8}, \pm \sqrt{-1}$ ;  $\frac{1}{2}, \frac{1}{8}, \dots$ ;  $-\frac{1}{2}, -\frac{3}{2}, \dots$ .  
 2. (a)-(c)  $(2x-1)(3x+1)(6x^2+x+1)$ ;  $(2x-5) \dots$ ;  $(x+1) \dots$ ;  
 (d)-(f)  $(2x-1)(3x+1) \dots$ ;  $(2x+1)(2x-3) \dots$ ;  $(x-1)^3(x^2+1)$ .  
 3.  $(8x^2+8x^2+1) \dots$  4. ...,  $(2x^2+9x^2-4)$ .  
 5.  $(5+5\sqrt{33}) \div 8$ . 6. 10. 7.  $t = 5$ .

## Pages 338-339†

2. 4. -- 6838. 3. -- -33, -4. -- -01. 4. 2. -- 84, -- -16, -2. -- -00.  
 6. -- -34579. 8. .6180, -1.6180. 10. .22. 11. .66.  
 12.  $x = 2.65$ . 13.  $x = 5.23$ . 14. 2.480, 2.510.  
 15. 47.82, .09 -- -8.

## Page 341 (top)

3. One step, from 2.3: 2.3099. 4. Three real.

## Pages 341-342

1. 2.166013. 3. 2.92. 4.  $\frac{1}{2}, 1.10; -\frac{1}{2}, -2, -.62, .73, 4.40$ .  
 5.  $(x+1) \dots (4x^2+8x+5)$ ;  $(x-1)(2x+5) \dots (4x^2-2x+1)$ ;  
 $(x-1)^6 \dots (x^2+4x+1)$ .  
 6. (3, 2), (3.6, -1.8),  $(-2.8, 3.2), \dots$  8. 32.23.

\* The answers given in groups are not in order.

† Here long dashes denote minus signs; short dashes, missing figures.

9.  $6.4\%$ . (One step from  $x = 1.03$ ). 11. .6931; 1.6094.  
 12.  $\sqrt{10}$ . 13. 3.059. 14. 6.179. 15. 1.843.

## Pages 344-345

1. 47.03 mi. 3. ...; 2.64, etc. 4. 15.8. 5. 30.

## Page 347

2. 139.6 in. 4. 50; 187.5; 5890.4 ft. 5. 471.24.

## Pages 348-349

3. 20 in./min.; 4 in./min.<sup>2</sup> 4. 10.8 in./sec. 5. .54 in./sec.<sup>2</sup>  
 6. At  $t=30$ , 81 ft. 12. .10472. 13.  $7.27 \times 10^{-4}$ .  
 14. .288 mi./sec. 15. .202 mi./sec.

## Page 350

1. 17900 mi. 2. 116 mi. 3.  $4.64 \times 10^8$  mi. 4.  $2.51 \times 10^8$  mi.  
 5.  $0''.81$ . 6. 19.2 mi. 8. 9 mi., approx. 9.  $\frac{1}{80}''$ .

## Pages 358-359

6. ...,  $117^\circ 29'.2$ ;  $115^\circ 24'$ , ...; ...,  $199^\circ 24'.8$ .  
 8.  $-.83898$ ;  $-.54416$ ;  $1.5417$ .  
 9.  $3.8877^{(r)}$ ,  $5.5371^{(r)}$ ;  $.7671^{(r)}$ ,  $5.5161^{(r)}$ ;  $3.0787^{(r)}$ ,  $6.2203^{(r)}$ .

## Page 360

1. 0, .0628, .1257, etc.; .0314, .0942, etc. 3. Max. at  $t = .00196$ ;  $\frac{\pi}{400}$  sec.

## Page 363

5. (b)  $-4.8 \sin 8t$ , (e)  $10\pi \cos\left(\frac{\pi}{4}t\right)$ , (f)  $-.21 t^2 \sin(t^2)$ .  
 6. (a)  $5.2359 \cos(3t+20)$ . 7. .000964. 8. 168; 54000.  
 10.  $v = -1.40$  cm./sec. 11.  $v = -8$  in./sec. 12.  $\omega = .6283^{(r)}$ /sec.

## Pages 364-365

1.  $1.05^{(r)}$ , ...,  $1.6^{(r)}$ , ...;  $\frac{3}{4}\pi^{(r)}$ , ... 2. 44.73.  
 3. .8097, 1.4903. 4. ...,  $-105 \cos^2(5t) \sin(5t)$ .

## Page 365

7. 273 per rad. 8.  $-.00597$ , .0267.

## Page 367

3. ...,  $(-18.794, -6.840)$ . 4. ...,  $(25, 323^\circ 8')$ , or  $(-25, 143^\circ 8')$ .  
 8.  $(\frac{3}{4}, -\frac{4}{5}, -\frac{3}{4}, \dots)$  or  $(-\frac{3}{4}, \frac{4}{5}, -\frac{3}{4}, \dots)$ . 9. 3530 mi.

# ANSWERS TO EXERCISES

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10. 6000 in./min.; 300 in./min.<sup>2</sup>      12. ...; -389.  
13. 73.89; 2.5.      14. 1.0027<sup>(7)</sup>.

## Pages 371-372

2.  $\cos \theta, -\sin \theta, \dots, \cos \theta - \sin \theta, \cos \theta.$       4. (a) [Factor].  
4. (b)-(c)  $\sec \theta + \tan \theta; \sec \theta.$       (f)  $-2 \sin \theta.$   
5.  $\theta + C; 2\theta + C.$       6.  $\sec^2 \theta; -\csc \theta \cot \theta.$   
7. (a)  $53^\circ 8', 306^\circ 52'.$       (b)  $45^\circ, 225^\circ, 71^\circ 34', \text{etc.}$   
    (c)  $8^\circ 43' 7, 81^\circ 16' 3;$  and two in Q III.  
8. (a)  $30^\circ;$  also II, III, IV.      (b)  $120^\circ, 240^\circ.$       9.  $2^\circ 45' 3; 87^\circ 14' 7.$   
10. 50000.      11.  $8^\circ 31' 8.$       12.  $45^\circ.$   
13.  $50^\circ 21' 4.$       14.  $14^\circ 2' 2 [\tan \theta = .25.]$

## Pages 373-374

1. (c)  $-10 t \csc^2 (5 t).$  (d)  $\frac{3}{t} \csc \left( \frac{3}{t} \right) \cot \left( \frac{3}{t} \right).$  (f)  $-2 \csc^2 \left( \frac{\theta}{2} \right) \cot \left( \frac{\theta}{2} \right).$   
    (g)  $\cot \theta.$  (h)  $3 \cot^4 \theta.$  (j)  $e^t \sec t (1 + \tan t).$   
2.  $\sec x; -\csc \theta \cot \theta; -\csc \theta; \sec^2 \theta.$   
3.  $\cos^2 \theta - \sin^2 \theta; \dots; \csc^2 \theta - \csc \theta \cot \theta; \sec^2 \theta - \csc^2 \theta; \dots$   
4. 1.6.      5. 1; -2.

## Page 375

2.  $80\pi.$  4. 320. 6.  $10\sqrt{2(1-\cos t)}.$  7.  $x = 10 \cos (2t + C).$   
9.  $30 \sin t \cos t; 15; 15.$

## Page 378

1.  $x = 50 (.2t - \sin .2t), y = \dots; \text{etc.}$  2.  $6\sqrt{2} \text{ in./sec.}; 12 \text{ in./sec.}$   
3.  $-2 \text{ ft./sec.}, \dots, .3328 \text{ ft./sec.}^2$  4.  $-44.82 \text{ in./sec.}$   
5.  $x = 20 \cos (2t - \pi/3), \dots, -9.787 \text{ in./sec.}$

## Pages 380-381

1. (a) Min. at  $t = .0067$ , max. at  $t = .0145.$  2.  $-.1 \cos 10t + C.$   
    (c) Max. at  $t = .2487$ , min. at  $t = .7487.$  3.  $Q = .0159 +.$   
5. (b)  $(\dots) \tan^2 \theta + C,$  (c)  $(\dots) \sin^{-2} \theta + C.$   
6. (a)  $\log \sin \theta + C,$  (b)  $2\theta - 2 \cos \theta + C.$   
7. (c)  $-\cos \theta + C,$  (f)  $\sin \theta + C,$   
    (g)  $\sin \theta - \cos \theta + C,$  (h)  $-\cos \theta + C.$

## Pages 384-385

7.  $4 \cos^2 \theta - 3 \cos \theta.$  8. (d)  $(\cos A + \sqrt{3} \sin A)/2.$   
9.  $\frac{63}{65}, \frac{59}{65}.$  10.  $\frac{63}{65}, -\frac{59}{65}.$   
11. (b)  $\tan 5\theta,$  (c)  $\cos A.$  12.  $5\sqrt{3} \sin 3t + 5 \cos 3t.$   
14.  $c = 10, A = 36^\circ 52' 2 = .6435^{(7)}.$

## Pages 386-387

1. (b)  $\frac{1}{2}\theta - \frac{1}{12}\sin 6\theta + C$ ; etc.      2.  $34'.3$ .
6.  $(\tan A + \tan B) \div (1 - \tan A \tan B)$ .
7.  $8^\circ 7'.8, 19^\circ 26'.4$ , etc.      8. ( $\neq 2, 4$ ),  $77^\circ 28'.3$ .
9. (6, 2),  $52^\circ 7'.5$ ; (-3, -4),  $86^\circ 49'.2$ .

## Page 388

2.  $-\cot 4\theta, \tan 6\theta, \cot 30^\circ \tan 20^\circ, -\tan 25^\circ \tan 5^\circ$ .
3.  $\frac{1}{2}(\sin 10\theta + \sin 2\theta)$ , etc.

## Page 389

1. (b)  $\frac{1}{2}[x\sqrt{x^2-25} - 25 \log(x + \sqrt{x^2-25})]$ . Use (41) with  $m = 0$ ; etc.  
 (e)  $\frac{1}{6}\tan^5\theta - \frac{1}{8}\tan^3\theta + \tan\theta - \theta + C$ .  
 (f)  $\frac{1}{6}\sin\theta \sec^2\theta (2\sec^2\theta + 3) + \frac{3}{8}\log(\sec\theta + \tan\theta) + C$ .  
 (h)  $\frac{1}{6}x^3(3\log x - 1) + C$ .      (i)  $-\frac{1}{18}e^{-2t}(2\sin 3t + 3\cos 3t) + C$ .
2.  $6\pi$ . (Cf. § 214.)      3.  $\pi^2/2$ .

## Pages 390-391

2.  $2\frac{1}{2}221, 220\frac{1}{2}221, 21\frac{1}{2}220$ , etc.      5.  $3\sin\theta - 4\sin^3\theta$ .      6.  $45^\circ$ .
7.  $\sin^{-1}(.005 F)$ .      8.  $.141 \text{ deg./deg.}$
9.  $c = .97985; 75^\circ 49'.3$ .      10.  $38.114 \text{ ft.}$
11.  $45^\circ \text{ N. E.}$       12.  $A/2$ .      13.  $45^\circ$ .
14.  $1.2113, .2218, 41^\circ 42'.9$ .      16.  $75^\circ 49'.3$ , or ...;  $165^\circ 49'.3$ .

## Page 394

1. 248; 97.2;  $134.14$ ; 1.      2. 2.      3. 2.
4.  $1318.3$ .      5. 102,500.      6.  $238\pi/3 \text{ cu. ft.}$
7.  $\pi - \pi^2/4$ .      8.  $750\pi \text{ cu. in.}$       9. 5000 lb.

## Page 398

5. 20%.      6.  $\frac{1}{8}$ .      7. 18000 lb.
8. 270000 lb.-ft.      9.  $4000/3 \text{ lb.-ft.}$       10.  $250\pi/3 \text{ lb.}$
11. 800 lb.      12. 752680 ft.-lb.      13.  $3333\frac{1}{3}$ .

## Pages 401-402

1. (a)  $52\frac{1}{2}$ .      (c)  $20\frac{1}{2} + 3\log 3$ .\*      2. (a)  $(\sqrt{1000} - 1)\pi/27$ .
2. (b)  $416\pi/3$ .      (d)  $48\sqrt{5}$ .      4. (a)  $18.33$ .\*
4. (b)  $k[(\pi^2 + 4)^{\frac{3}{2}} - 8] \div 3$ .      (c)  $\sqrt{2}(e^\pi - 1)$ .      (d)  $10\pi$ .
6.  $2133\frac{1}{3} \text{ lb.-ft.}$       7.  $128000\pi \text{ ft.-lb.}$

\* Use formula (41), p. 497, with  $m = 0$ .

# ANSWERS TO EXERCISES

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## Page 405

- |           |                         |           |              |
|-----------|-------------------------|-----------|--------------|
| 1. 90.    | 2. $125\frac{1}{105}$ . | 3. 78.    | 4. $10\%$ .  |
| 5. 819.2. | 6. $171\frac{1}{4}$ .   | 7. 11.25. | 8. $170\%$ . |

## Pages 407-408

- |                             |   |
|-----------------------------|---|
| 1. $16\frac{1}{21}$ .       | 3. (a) 4, 4. (b) -12, -16. (c) 5, 10.         |
| 3. (d) -3, 6.               | 4. (a) 2, 4. (b) 2, 1. (c) 6, 4.              |
| 4. (d) 2, 12. (e) 5, 4.     | 6. (a) (3, -1, 17), min. (b) (0, 0, 40), max. |
| 6. (c) (0, 1, 17), neither. | (d) four max., one min. 7. (6, 5).            |

## Page 411

- |                                  |                                |                          |
|----------------------------------|--------------------------------|--------------------------|
| 1. $103\frac{1}{8}$ .            | 2. $\bar{y} = 16\frac{1}{8}$ . | 3. $\bar{y} = 80$ .      |
| 4. .0795 (= 5%).                 | 5. .0349 (= .1%).              | 6. 17.26; 370.67; .7072. |
| 8. $170\%$ ; $\frac{1}{8}$ ; ... | 9. $40/\pi$ .                  | 10. $.4/\pi$ .           |

## Pages 412-413

- |                      |                       |                        |
|----------------------|-----------------------|------------------------|
| 3. 70 cu. ft.        | 4. $5940 \pi$ cu. in. | 5. $1280 \pi$ cu. in.  |
| 6. $672 \pi$ cu. in. | 8. $1200 \pi$ cu. in. | 9. $304 \pi/3$ cu. in. |

## Page 414

- |   |                            |                    |
|---|----------------------------|--------------------|
| 1. $10\sqrt{5}$ .   | 2. $12\frac{1}{27}$ .      | 3. $\frac{4}{8}$ . |
| 4. $\frac{1}{8}$ .  | 5. $360 \pi$ ; $720 \pi$ . | 6. 3.1 in.         |
| 7. 16000 lb.-ft.  | 8. $800 \pi/3$ lb.         | 9. 1.00003.        |
| 10. $2400 \pi^2$ [ $A_z$ comes out $48 \pi \sqrt{100-x^2}$ ]. |                            |                    |
| 11. 76800 lb. [ $w$ comes out: $3\sqrt{x}$ ].                 |                            | 12. $30\%$ cu. ft. |

## Pages 417-418

- |                                  |                   |                                  |
|----------------------------------|-------------------|----------------------------------|
| 2. 900; 2500.                    | 3. 420; 7656.     | 4. 31360; 99500.                 |
| 5. \$1252.50.                    | 6. \$4350.        | 7. \$615.                        |
| 8. ..., 16 ( $1.5^{30} - 1$ ),   | 10. .003171 $W$ . | 12. 3435.60.*                    |
| 13. \$12080.                     | 14. \$642.        | 15. \$1027.50.                   |
| 16. \$285.75 (= \$22.50 + $S$ ). |                   | 17. $\sqrt[6]{2}$ , $\sqrt{2}$ . |

## Pages 421-422 †

- |                     |                |                   |
|---------------------|----------------|-------------------|
| 1. \$22607.         | 2. \$8480.20.  | 3. \$1639.20.     |
| 4. \$1188.90.       | 5. \$37934.    | 6. \$1685.54.     |
| 7. Life, by \$3.53. | 8. \$8.84 +.   | 9. (a) \$14.99 -. |
| 9. (b) \$8.47 -.    | (c) \$16.06 -. | (d) \$74.30 +.    |
| (e) \$21.47 +.      | 10. \$187.66.  |                   |

\* Using six-place logarithmic tables.

† Five-place tables will not give some of these results very closely.



## Pages 424-425

- |                   |                  |               |
|-------------------|------------------|---------------|
| 1. \$7494.03.     | 3. \$3618.33.    | 4. \$3419.16. |
| 5. \$1971.16.     | 6. \$58.96.      | 7. \$55.85-.  |
| 8. \$6682.20.     | 10. (a) \$63.91. | (b) \$56.03.  |
| 10. (c) \$234.96. | 11. \$6065+.     | 12. \$672.97. |

## Page 426

- |                       |                 |               |
|-----------------------|-----------------|---------------|
| 1. \$372.43+\$564.81. | 3. (a) \$853.   | (b) \$512.81. |
| 3. (c) \$4805.13.     | (d) \$10127.30. | (e) \$34.25.  |
| 4. \$173.23+.         | 5. \$334.59.    |               |

## Page 430

- |  |  |
|--|--|
| 1. $1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\frac{x^4}{4!}$ , etc.   | 4. $x+\frac{x^2}{4}+\frac{x^3}{18}+\frac{x^4}{96}$ . |
| 5. .09967.   | 6. $x-x^2/3!+x^3/5!$ .                               |
| 11. .493108; .049986.  | 12. $a^5+5a^4x+10a^3x^2$ , etc.                      |
| 13. $a^n+n a^{n-1}x+\frac{n(n-1)}{1 \cdot 2} a^{n-2}x^2 \dots$ |  |

## Pages 432-433

- |   |  |
|---|--|
| 1. (e) $1-\frac{x^2}{3}-\frac{x^4}{9}-\frac{5x^6}{81}$ .    | (f) $1+\frac{x^4}{2}+\frac{3x^6}{8}$ .                                 |
| (g) $1+x+x^2$ , etc.  | (h) $\frac{1}{9}-\frac{2x^4}{27}+\frac{x^6}{27}-\frac{4x^{12}}{243}$ . |
| 2. $-(x+x^2/2+x^3/3)$ , etc.).                              | 3. -.05129, -.05033.   |
| 4. $x+\frac{1}{6}x^4-\frac{1}{66}x^7+\frac{1}{160}x^{10}$ . | 5. .5032.  |

## Page 435

- |   |
|---|
| 1. (a) $\log \sqrt{-1} = 1.5708 \sqrt{-1}$ , 4.7124 $\sqrt{-1}$ , etc.          |
| (b) $\log (.5+.86603 \sqrt{-1}) = 1.0472 \sqrt{-1}$ , 4.1888 $\sqrt{-1}$ , etc. |

## Pages 437-438

- |   |
|---|
| 3. $y = 10x+3x^2$ ; $y = -7+.2x^2$ ; $y = -5-2x+.1x^2$ .              |
| $y = 11+x^2-\frac{1}{4}x^3$ ; $y = 2.47+.0515x+.00165x^2-.00005x^3$ . |
| $A = 1.4x^2-.1x^3$ ; etc.   |
| 4. $y = 125-.5x$ ; $y = 20x-x^2$ .                                    |

## Page 439

- |              |                                 |                |
|--------------|---------------------------------|----------------|
| 6. 1.003984. | 9. $y = 28-5x+\frac{1}{4}x^2$ . | 10. \$1022.50. |
|--------------|---------------------------------|----------------|

# ANSWERS TO EXERCISES

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## Pages 441-442

1. 120; 15600.
2. 5040.
3. 6720.
5.  $10,000! + 9500!$ .
6. 64.
7. 504.
8.  $20! \times 28! \div 8!$ .
9. 8.
10. 1,814,400.
11. 48.
12. 64, 48.

## Pages 445-446

1. (a)-(d) 252; 5005; 38760; 12650. (l)  $47! \div (36!6!5!)$ .
- (n) 8,778,000.
3. 45.
4. 895440.
6. 288.
8. 30240.
9.  $16800 \times 18! \div 13!$ .
10. 3696.
11.  $2880 \times 13!$ .
12. 11760.
13. 5040.
14. 56.
15. ..., 220.

## Pages 449-450

2.  $\frac{2}{1001} \frac{240}{1001}$ .
3. .34-.
4. .004917, .1598.
5. (c) .007128.
6. .0401.
7.  $\frac{9}{182}$ .
8.  $\frac{1}{11050}$ .
9. (b)  $\frac{1}{1024}$ .
10. (b)  $\frac{36}{343}$ .
11. (b) .081.

## Page 451

1.  $\frac{5}{16}$ , .05427, .2257.
2. .288.
3. .512.
4. .3501.
5.  $\frac{7}{1588}$ .
6. .000404.
7. .0108.

## Pages 455-456

1. 9%, 91%.
2. ..., 28 m. closer.
4.  $\frac{1}{4}$ .
5. ..., 98%.
6. .4724, .3829.
7. 5.529.

## Page 458

1.  $8\frac{8}{105}$ ; 7.53.
2. .0000462; etc.
3. (a)  $\frac{1}{6}$ ,  $9\frac{1}{80}$ .
3. (b) .8, -1, approx.
4.  $W = 35.33 + .04175 T$ .

## Page 459

1.  $7.6185 \times 10^{10}$ , approx.
2. .278, approx.
3. .0225.
4.  $W = 6.9823 T + 105.16$ .
5. .00811.
6.  $\bar{y} = 3.95 x + 52$ ;  $\bar{x} = .0805 y - 2.82$ ;  $i = .318$ .

## Page 463

2.  $92 + 34i$ ,  $17\frac{1}{18} + 7\frac{1}{18}i$ , -,  $13 + i$ ,  $8 + 2i$ , -,  $2 - 11i$ ,  $\frac{3}{26} - \frac{1}{18}i$ .
3.  $\pm[(3+i)/\sqrt{2}, -, (1+3i)/\sqrt{2}, 1-2i, 3-2i, (1-5i)/\sqrt{2}, 4+i, (3-5i)/\sqrt{2}, -, (9-7i)/\sqrt{2}, 2+5i, 5-6i]$

## Page 466

3. (b)  $2\sqrt{2} \text{ cis } 225^\circ$ . (e)  $8 \text{ cis } 150^\circ$ . (g)  $3 \text{ cis } 180^\circ$ .  
 4. (b)  $3.2140 - 3.8302i$ . (e)  $-6 - 6\sqrt{3}i$ . (f)  $4\sqrt{2}(-1+i)$ .  
 5.  $\text{cis } 280^\circ; -$ ;  $7.2812 \text{ cis } 208^\circ 1'$ .

## Pages 467-468

1. (d)  $30 \text{ cis } 220^\circ = \dots$  (g)  $250 \text{ cis } 150^\circ = \dots$  (h)  $\frac{9}{32}i$ .  
 2.  $-.75i$ . 3.  $2.1426 - 2.5535i$ .

## Page 469

2. (b)  $2 \text{ cis } 75^\circ$ ,  $2 \text{ cis } 165^\circ$ , etc. (e)  $3 \text{ cis } 140^\circ$ , etc.  
 3.  $.80902 + .58779i$ ;  $-.30902 + .95106i$ , etc.

## Page 470

1. (b)  $\text{cis } 22^\circ 30'$ ,  $\text{cis } 67^\circ 30'$ , etc. (c)  $(\sqrt{3}+i)/2$ ,  $(1+\sqrt{3}i)/2$ ,  $i$ , etc.  
 (h)  $i$ ,  $-(\sqrt{3}+i)/2$ , etc. (i)  $\text{cis } 22^\circ 30'$ ,  $\text{cis } 112^\circ 30'$ , etc.

## GENERAL REVIEW, pages 475-484

## Chapters I-VI

1. 150. 3. 45000 lb. 4. 11984 lb., etc.  
 5. 146.45 sq. in.; ...; 277.02 cu. in. 6. 320000; ...; 13500.  
 8. \$197.72. 9. -3 per min. 10. 2298 yd. 12. 3.2282.  
 13. 62.5; 127.93 sec. 14. 2560 lb.  
 15. 26.67 deg./sec<sup>2</sup>; 291600°.

## Chapter VII

1.  $2x/(x^2+1)$ ;  $2.17145/x$ ;  $-$ ;  $x(1+2\log x)$ ;  $e^x/(e^x+1)^2$ .  
 2. ...;  $\log x^{20} + C$ ;  $\frac{1}{2}(e^{2x} - e^{-2x}) - 2x + C$ .  
 3.  $1/5e$ . 4. 22.14%. 5.  $V = 20e^{.003T}$ . 8.  $y = 7.44/\sqrt{x}$ .

## Chapter VIII

1.  $\sqrt{34}$ , ...,  $59^\circ 2'$ . 4.  $\frac{(x+5)^2}{64} + \frac{(y+2)^2}{16} = 1$ ,  $x^2 = -20(y-2)$ ,  
 5.  $(x-38400)^2 = -102400(y-14400)$ ; ...  
 8. ...; 3.75 ft.;  $(0, \frac{500}{9})$ ; etc. 9.  $(x-3)^2 + (y-4)^2 = 25$ .

## Chapter IX

1.  $\pm 2.3142$ ,  $\pm .55786$ . 3. Two linear, one quadratic.  
 4.  $-1.6751$ ,  $-.5392$ ,  $2.2143$ .

# ANSWERS TO EXERCISES

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## Chapter X

5. 40 in./sec.      6.  $-5.878, -1525$  per sec;  $t = \frac{1}{120}$ , etc.

## Chapter XI

1.  $\cos \theta$ .      2.  $-\frac{5}{8} \cos 6t + C; \dots; -\log \cos \theta + C$ .  
 3.  $-\frac{1}{2}[\csc \theta \cot \theta + \log(\csc \theta + \cot \theta)] + C; \dots; -\frac{1}{12} \cos 6\theta - \frac{1}{4} \cos 2\theta$ .  
 4.  $10^\circ 33', 79^\circ 27', 190^\circ 33', 259^\circ 27'$ .  
 5.  $A+B: -\frac{56}{65}, \frac{33}{65}, -\frac{56}{33}$ , etc.;  $A-B: -\frac{16}{65}, \frac{63}{65}, -\frac{16}{63}, \dots$   
 6.  $.1\sqrt{10}; 2\frac{1}{25}$ .      7.  $.2$  sec.; 8;  $-239.03$  units per sec.  
 9.  $10.63, 5792; t = .003678; 127$  times per sec.

## Chapter XII

3.  $16.5\pi \sqrt{17} - \frac{1}{8}\pi \log_e(4 + \sqrt{17})$ . [Use (44), (41), p. 497.]      4. 16.

## Chapter XIII

2. \$104, nearly.      3. \$18.74+.      4. \$65.90.      5. \$4180, nearly.

## Chapter XIV

1. 358800.      2. 15504.      3. 302,400.  
 4.  $1.71 \times 10^{-8}$ .      5. .1285.      7. 36 meters nearer.  
 8.  $y = .901x$ .      9.  $\bar{y} = 33.41 + .52x, \bar{x} = 25.72 + .61y; i = .3172$ .

## Chapter XV

1.  $\dots; -20\frac{1}{17} + 12\frac{1}{17}i$ .      2.  $\text{cis } 18^\circ, i, \dots; -; 1.3797 \text{ cis } 10^\circ 37'.6$ , etc.

## Miscellaneous

1.  $V = 9e^{-.00931T}; 50.9$ .      2.  $(x+1)^2 + y^2 = 4$ .  
 4. .342.      5.  $45^\circ, 90^\circ, 210^\circ, 225^\circ, 270^\circ, 330^\circ$ .  
 6.  $59^\circ 2'; 239^\circ 2'$ .      9.  $-2, \frac{1}{2}, 2.12$ .      10.  $.2$  in./sec.; 5 in.  
 12.  $(b) 62500\pi$  lb.      13.  $1,014,500$  ft.-lb.      14.  $(a) x^2/(x+1)^2$ .  
 14.  $(b)-(d) \sec \theta \tan \theta; \sec^2 x; [x \sin x + 2(\cos x - 1)] \div x^3$ .  
 15.  $(a)-(c) -\frac{1}{8} \csc^2 t + C; \frac{1}{8}(x^2 - 100)^{\frac{3}{2}} + C; .01x/\sqrt{100 - x^2} + C$ .  
 16.  $2.1752; .3466$ .      17.  $(y-9)^2/225 - x^2/400 = 1$ .  
 18.  $5.8\%$ .      19. Ellipse;  $y = \pm 2\sqrt{10}, x = \pm 2$ .  
 20.  $\dots; .10256$ .      21.  $+\$6.08$ .      23.  $79^\circ 41'.7$  or  $36^\circ 52'.2$ .  
 24.  $\frac{1}{2}260$ .      25.  $.26; .94$ .      26.  $i = 100e^{-.500t}, Q = .1986+$ .  
 27.  $6.53$  ft.      29.  $.165$ .      30.  $49.6; (10.85, -16.56); \dots$ .  
 31.  $5\sqrt{10}$ , left and up  $63^\circ 26'$ ; hyperbola;  $69.31$ .      34.  $80$  ft.





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